WOODARD & CURRAN

Town of Lexington Stream Management Plan

for the

Charles River Watershed

#223267

Town of Lexington, MA

April 2011

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EXECUTIVE SUMMARY

PROJECT DRIVERS

Old and deteriorated drainage and stream passage infrastructure and sediment buildup in Lexington's waterbodies has reduced the capacity of the drainage system, causing flooding, and has negatively affected water quality and quantity, leading to poor stream health. The streams in the Charles River basin generally have small watersheds and low gradients, resulting in low streamflow. Numerous reports from residents and town staff identified flooding problems during wet weather conditions, likely due to the sediment buildup and capacity issues of the drainage system.

SCOPE OF WORK

This report presents a stream management plan for the Charles River watershed within the Town of Lexington ("the Town"). This study explores and develops a cohesive strategy for drainage rehabilitation and long-term stream maintenance that will enable the Town to maintain drainage and stream flow, reduce sedimentation, and enhance streambank stability, to address the flooding and environmental issues.

Specific project objectives include:

- Perform watershed survey and research historical stream data;
- Identify problem areas in the stream and infrastructure network within the watershed;
- Provide recommendations for improvements;
- Develop permitting and implementation methodology for recommendations; and
- Evaluate funding opportunities.

FINDINGS

Based upon the results of the field work conducted by W&C and the Town of Lexington and from the compilation of data, we conclude that:

1. Culverts were commonly obstructed, including culverts that conveyed outfall flow.
2. Drainage outfalls were generally clear of obstructions, except those that were in stream channels impacted by organic debris and sedimentation.
3. Sediment at culverts appears to be predominately from settlement of organic and inorganic material caused by downstream obstructions and low gradient stream flow.
4. In addition, over time, sand from winter maintenance activities has contributed to clogged culverts and outfalls.

5. For sediment issues, the Town should prioritize projects that clear stream obstructions and sediment in culverts, outfalls and stream channels, as opposed to upstream drainage infrastructure (pipe and catch basin) cleaning.

6. Infrastructure structural conditions varied considerably. However, the culvert at Beaver Brook and Concord Avenue is failing and causing road failure, undersized culverts at Waltham Avenue and Valleyfield Street are contributing to local flooding, and the culverts on Hardy's Pond Brook at Concord Ave show signs of distress.

7. Hydraulic limitations in Waltham are affecting Hardy's Pond Brook in Lexington.

8. To achieve a routine maintenance program for the drain outfalls and stream system, the Town must first undertake projects requiring capital funding and comprehensive permitting. A routine maintenance program can begin once the sediment problems stabilize.

9. Several opportunities exist for stream and wetlands protection and restoration.

RECOMMENDATIONS

Recommendations are grouped into five categories:

- in-stream recommendations (infrastructure restoration, drainage restoration, and wetlands protection);
- drainage investigation recommendations;
- roadway and drainage system O&M recommendations;
- recommendations for drainage restoration practices; and
- recommendations for coordination with EPA's Phase II Small MS4 General Permit.

The following is a summary list of W&C's recommendations.

High Priority

- Project #1: Infrastructure Restoration, Concord Avenue Crossing at Beaver Brook
- Project #2: Infrastructure Restoration, Valleyfield Street at Clematis Brook
- Project #3: Drainage/Infrastructure Restoration, Clematis Brook around Waltham Street
- Project #4: Drainage Investigation, Middle Street at Hobbs Brook
- Action Item #1: Address extensive sedimentation within in-stream detention basin on 80 Hayden Avenue property and Juniper Hill Brook
- Action Item #2: Investigate potential dog waste dumping in drainage system around Hasting School/School Street/Roosevelt Road

- Action Item #3: Increase Street Sweeping and Catch Basin Cleaning frequencies on Main Roads at Stream Crossings

Medium Priority

- Project #5: Drainage Restoration, Clematis Brook from Bowman School to Pleasant Street
- Project #6: Infrastructure Restoration, Concord Avenue at Hardy's Pond Brook
- Project #7: Wetlands Protection, Dunback Meadows at Clematis Brook
- Action Item #4: Address moderate sedimentation and erosion in area between Hayden Avenue and Concord Avenue on Juniper Hill Brook and minor sediment accumulation between Hayden Drive and Route 2 on Hardy's Pond Brook
- Action Item #5: Work with Waltham to address drainage restrictions at culvert near Leitha Drive

Low Priority

- Project #8: Drainage Investigation, Chester Brook at Waltham Street
- Project #9: Wetlands Protection, Beaver Brook between Concord Avenue and Route 2
- Project #10: Wetlands protection, Chester Brook off Waltham Street
- Action Item #6: Address lawn encroachment, minor channelization and bank erosion on Juniper Hill Brook below Concord Avenue
- Action Item #7: Coordinate stream inspection, general clean-up and water quality monitoring with Watershed Stewardship Program
- Action Item #8: Educate residents about Town of Lexington General Bylaws Chapter 100-8 Dumping and Littering

PERMITTING

The prioritized projects and the long-term drainage restoration work require numerous local, state, and federal permits. W&C identified the probable permits associated with each recommendation and presented a recommended permitting approach.

FUNDING

W&C also assessed over 50 federal and state grant and loan opportunities to identify potential funding opportunities for the recommended work. Based on this assessment, W&C presents a prioritized summary of grant and loan opportunities, including non-traditional grant sources, based on specific projects, funding program requirements, funding range, schedule for applications, estimate of application effort, targeted recipients, and other relevant information. To assist with funding, W&C developed an engineer's opinion of probable budgetary cost for structural projects ranked as high and medium priority.

1. INTRODUCTION

The Town of Lexington, Massachusetts ("the Town") is situated within three major watersheds: the Charles River watershed, the Mystic River watershed, and the Shawsheen River watershed. Each of these watersheds contains a number of streams, ponds and wetlands, all of which play significant and multiple roles in pollution prevention, stormwater management and in providing wildlife habitat. In a properly functioning system, the brooks throughout town could provide wildlife habitat, environmental enhancement, and serve as a link between many open spaces and recreational areas in town. These streams could also provide floodwater protection and drainage for town neighborhoods and commercial areas.

Many of these waterways have been altered since the mid 1800's through town and infrastructure development as well as past agricultural practices, resulting in a network of waterways that now bear little resemblance to their historical character. Multiple sources of stormwater runoff and associated pollutants, in conjunction with physical landscape alterations, have degraded many of these waterways such that their original functions and capacities are no longer supported. Consequently, this reduction in function has led to increased flooding in portions of town as well as a general decrease in water quality and ecological value. Gaining an understanding of the existing characteristics of these waterways and associated wetlands, as well as their stormwater infrastructure, is essential in effectively managing these resources and protecting property from flooding, while restoring stream hydrology and health.

This report presents a stream management plan for the Charles River watershed within the Town of Lexington. On behalf of the Town, Woodard & Curran Inc. (W&C) conducted an assessment of the main streams within the sub-basins of the Charles River watershed located within the Town to identify specific problem areas and create a long term maintenance program that will enable the Town to maintain drainage and stream flow, reduce sedimentation, and enhance streambank stability. This study explores and develops a cohesive strategy for drainage rehabilitation and restoration.

1.1 DRIVERS FOR STUDY

Persistent flooding and protection of wildlife habitats are primary drivers for this study. Old and deteriorated drainage and stream passage infrastructure and sediment buildup in Lexington's waterbodies has reduced the capacity of the drainage system, causing flooding, and has negatively affected water quality and quantity, leading to poor stream health. In some instances, culverts have been almost entirely blocked by sediment. In other cases, culverts and headwalls have caved in, and stream banks are eroding.

Lexington's streams within the Charles River basin generally have small watersheds and low gradients, resulting in low streamflow. In addition, there are no substantial headwater storage impoundments from which water is released to the streams, further contributing to low flow conditions. Numerous reports from residents and town staff identified the Valleyfield Street, Hardy's Pond Brook, and the Western Avenue/Middle Street areas as having significant and/or nuisance flooding problems during wet weather conditions, likely due to the sediment buildup and capacity issues of the drainage system.

The U.S. Environmental Protection Agency released a draft National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges from Small Municipal Separate Storm Sewer Systems (MS4) located in north coastal Massachusetts ("EPA Phase II Small MS4 General Permit"), which covers the Town of Lexington. This draft General Permit identifies Best Management Practices the Town must implement to control stormwater pollution. The Town is required to develop a Phosphorous Control Plan

(PCP) to reduce phosphorus in stormwater by 57.8% from the Town's portion of the watershed, through both structural and non-structural controls.

1.2 PROJECT OBJECTIVES

The primary goal of this study was to create a program that can both restore drainage and enhance streams. The three specific objectives of this study were to identify:

- A means of improving drainage throughout the watershed;
- Infrastructure problems/failures; and
- Opportunities for ecological enhancement.

Additionally, information gathered from this study can be used to support implementation of State and Federal stormwater management requirements as well as to support management of other watersheds within the community.

W&C worked collaboratively with representatives from the Town Engineering Division, Conservation Office, Highway Division, and the Watershed Stewards and also solicited input from town residents. In addition, W&C worked with U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP), U.S. Army Corps of Engineers, the Massachusetts Department of Transportation (MassDOT), and the East Middlesex Mosquito Control Program. A public meeting was held on September 23, 2010. A final public meeting will be held to present recommendations and priorities. This collaborative approach helped to:

- Develop an on-going and interactive dialogue with the citizens of Lexington;
- Identify drainage needs, infrastructure restoration and restoration opportunity areas;
- Create an efficient and cost-effective permitting process;
- Prioritize projects, including costs and benefits; and
- Target funding alternatives.

2. STREAM ASSESSMENT

This section presents an assessment of streams in the Charles River watershed within the Town of Lexington. The assessment included a detailed field investigation of the streams in the Charles River watershed, research of historical stream alignments and stream cross sections (Appendix A), and cataloguing roadway and drainage system operation and maintenance (including snow management, sand and salting applications, street sweeping, and catch basin cleaning).

2.1 WATERSHED DESCRIPTION

As previously discussed, the Town is situated within three major watersheds: the Charles River watershed, the Mystic River watershed, and the Shawsheen River watershed. Figure 2-1 shows the major watershed divides in Lexington, according to MassGIS Major Drainage Basins (last updated in March 2003) and the Town's delineation of the Charles River watershed.

2.1.1 Sub-Basins

For this study, the Charles River watershed within the Town was divided up into six sub-basins, as further characterized in Table 2-1 and shown on Figure 2-1. Sub-basins presented in Figure 2-1 were delineated by the Town of Lexington, and modified by W&C at the town border. It should be noted that Clematis Brook flows into Beaver Brook, Chester Brook is a tributary of Hardy's Pond Brook, and Juniper Hill Brook is a tributary of Hobbs Brook.

Table 2-1: Charles River Watershed Sub-basins

Sub-basin	Area (Acres)	Impervious Area (Acres)	Percent Impervious	Approximate Stream Length (miles)	Roadway (Miles)
Beaver Brook	374.3	47.9	12.8	2.3	6.2
Chester Brook	162.5	33.6	20.7	0.6	1.9
Clematis Brook	958.9	192.8	20.1	5.3	20.8
Hardy's Pond Brook	381.1	63.6	16.7	2.5	6.7
Hobbs Brook	1122.6	205.5	18.3	5.0	23.8
Juniper Hill Brook	244.0	51.2	21.0	1.1	5.3

Source: MassGIS, Town of Lexington, W&C

Approximately 18% of the Charles River watershed in Lexington is covered by impervious surfaces. Impervious cover includes buildings, roads, sidewalks, driveways, parking lots, and other surfaces that do not allow rainwater to infiltrate into the ground. Impervious surfaces contribute to increased stormwater runoff, route surface pollutants quickly to waterbodies and restrict the recharge of groundwater. Studies from the Center for Watershed Protection[1] have shown that small urban watersheds that have greater than 10% of their land area covered by impervious surfaces generally have impaired water quality. Pervious areas allow the infiltration of precipitation to recharge shallow and deep groundwater and preserve the hydrologic integrity of the watershed. According to the EPA, "although IC is not the direct factor causing the impairment, it is a good indirect or surrogate measure because of the relationship between impervious

[1] Impacts of Impervious Cover on Aquatic Systems (Center for Watershed Protection, 2003).

surfaces and stormwater-related water quality problems."[2] In the simplest terms, reduction in or management of impervious cover should result in reduction in stormwater quantity, thereby resulting in reductions in flooding, reduced sediment transport to stream channels, and restoration to water quality and stream health. EPA's draft North Coastal Phase II Small MS4 General Permit, which covers the Town of Lexington, includes numerous requirements relating to tracking and reducing impervious cover.

2.1.2 Water Quality in the Charles River Watershed in Lexington

As designated in Massachusetts Surface Water Quality Standards (314 CMR 4.00), the streams within the Charles River watershed in Lexington are considered Class B waterbodies, with the exception of Cambridge Reservoir and tributaries thereto (including Hobbs Brook). Cambridge Reservoir is a drinking water supply, and therefore is a Class A waterbody per the state water quality standards and is protected as an Outstanding Resource Water. Streams within the Hobbs Brook sub-basin drain to this waterbody. Figure 2-2 indicates the water quality standard of each stream.

Class A waterbodies are designated as excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation.

Class B waterbodies are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation.

The proposed Massachusetts Year 2010 Integrated List of Waters identifies impaired waterbodies and the reason for impairment (pollutants of concern). Waterbodies are impaired when they do not meet surface water quality standards and when they do not have the capacity to support designated uses (aquatic life support, fish and shellfish consumption, drinking water supply, and primary (e.g., swimming) and secondary (e.g., boating) contact-recreation), as identified in the surface water quality standards.

Waters that are impaired or threatened for one or more uses and require development of a TMDL are known as Category 5 waterbodies as designated on the 303(d) list. Once a water body is listed in Category 5 on the 303(d) list, development of a TMDL is required for each pollutant of concern associated with that waterbody.

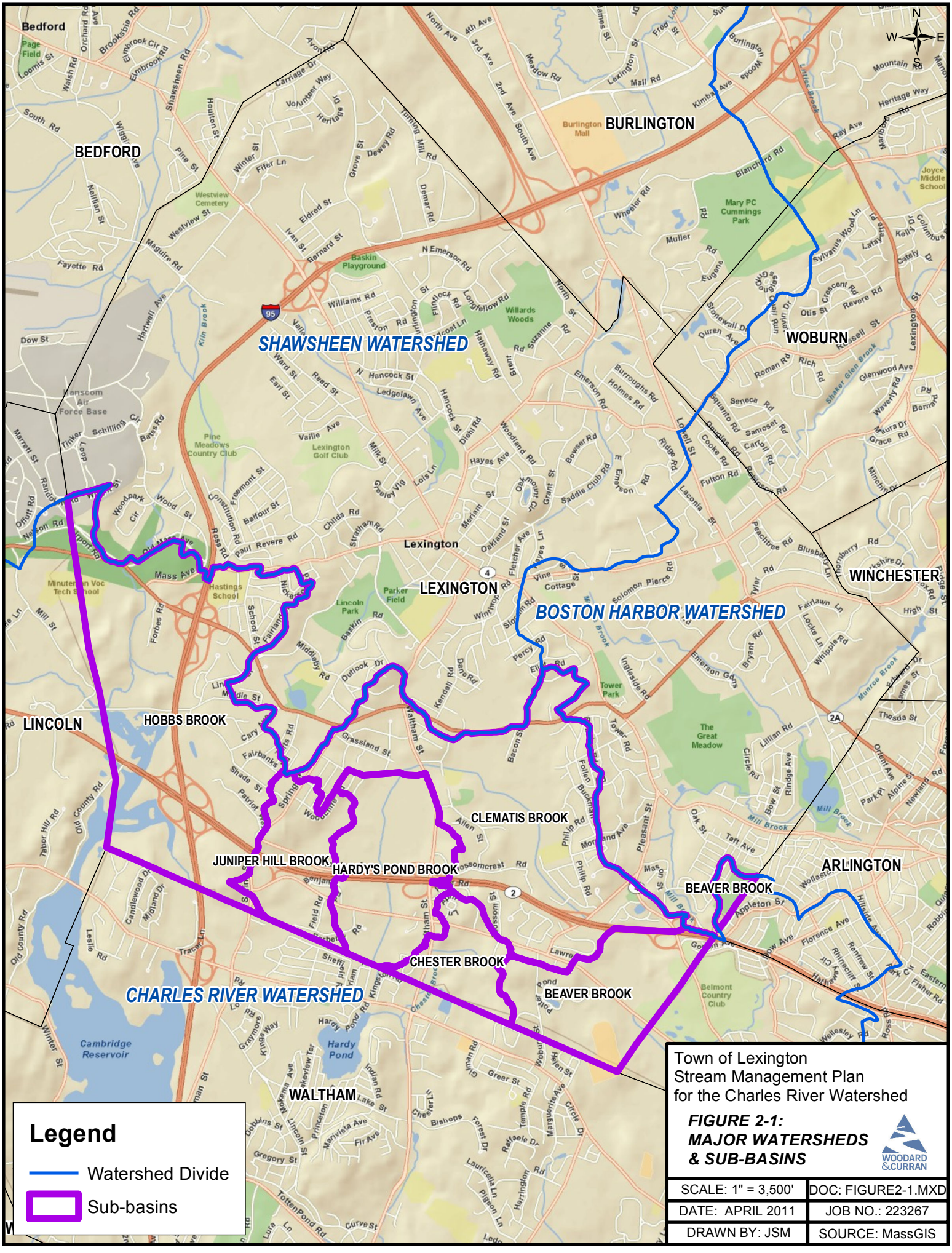
There is a long list of pollutants of concern assigned to the Charles River and its tributaries, most notably phosphorous and pathogens. As shown in Figure 2-2, in Lexington within the Charles River watershed, two waterbodies are identified on the 303(d) list:

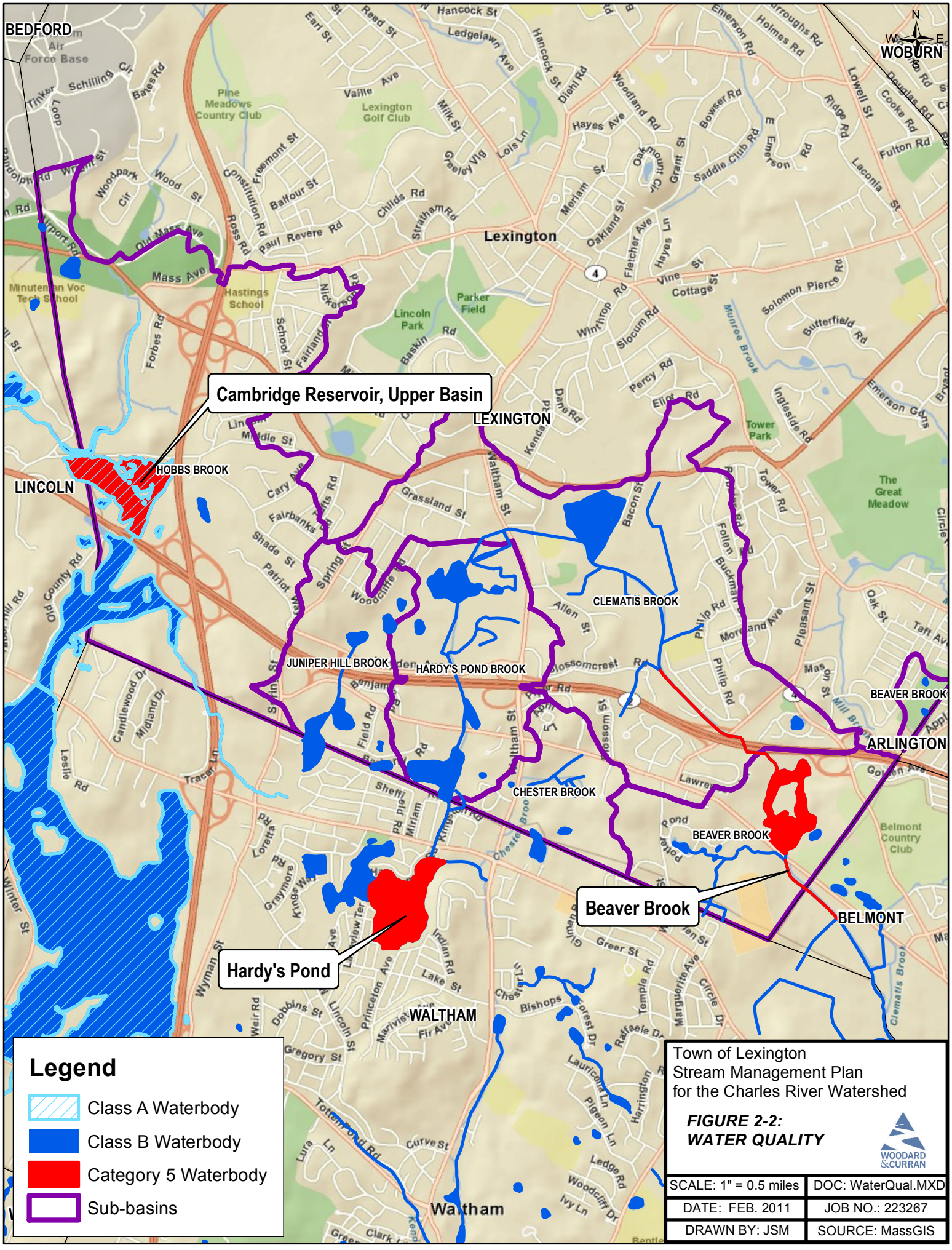
- Beaver Brook requires development of a TMDL for the following pollutants of concern: excess algal growth, dissolved oxygen, sedimentation/siltation, turbidity, organic enrichment (sewage), taste and odor, total phosphorus, and e. coli. The Draft TMDL for nutrients addresses excess algal growth, dissolved oxygen, turbidity, and total phosphorus in Beaver Brook. The Final TMDL for pathogens addresses the e. coli impairment.
- The 44-acre upper portion of Cambridge Reservoir requires development of a TMDL for the following pollutants of concern: turbidity and aquatic plants (macrophytes).

[2] http://www.epa.gov/owow_keep/tmdl/tmdlsatwork/eagleville_brook.html

A TMDL is the greatest amount of pollutant that a water body can accept and still meet water quality standards for protecting public health and maintaining the designated beneficial uses of those waters for drinking, swimming, recreation, and fishing. TMDL reports identify the potential sources of contamination, establish pollutant loading limits, and outline corrective actions to achieve these limits. EPA and the MassDEP recognize that restoring polluted waters is a long-term process. Three TMDLs are relevant to the Town of Lexington:

- A Draft TMDL for Nutrients in the Upper/Middle Charles River;
- A Final Pathogen TMDL for the Charles River watershed; and
- A Final TMDL for Phosphorus in the Lower Charles River Basin, which does not specifically address water quality impairments for waterbodies with Lexington, but does include a waste load allocation and phosphorus reduction of 48% for the Charles River watershed upstream of the Watertown Dam. To achieve the reduction of phosphorus at the Watertown Dam, the TMDL implementation plan specifies that Lexington should reduce annual phosphorus loading by 57.8% from the Town's land area in the Charles River watershed.


BEDFORD
BURLINGTON
WOBURN
WINCHESTER
ARLINGTON
LEXINGTON
LINCOLN
WALTHAM
SHAWSHEEN WATERSHED
BOSTON HARBOR WATERSHED
CHARLES RIVER WATERSHED
HOBBS BROOK
CLEMATIS BROOK
JUNIPER HILL BROOK
HARDY'S POND BROOK
CHESTER BROOK
BEAVER BROOK
BEAVER BROOK
Legend
Watershed Divide
Sub-basins
Town of Lexington
Stream Management Plan
for the Charles River Watershed
FIGURE 2-1:
MAJOR WATERSHEDS
& SUB-BASINS
WOODARD &CURRAN
SCALE: 1" = 3,500'
DOC: FIGURE2-1.MXD
DATE: APRIL 2011
JOB NO.: 223267
DRAWN BY: JSM
SOURCE: MassGIS


BEDFORD
WOBURN
LEXINGTON
LINCOLN
ARLINGTON
BELMONT
WALTHAM
Waltham
Cambridge Reservoir, Upper Basin
HOBBS BROOK
CLEMATIS BROOK
JUNIPER HILL BROOK
HARDY'S POND BROOK
CHESTER BROOK
BEAVER BROOK
BEAVER BROOK
Beaver Brook
Hardy's Pond
Legend
Class A Waterbody
Class B Waterbody
Category 5 Waterbody
Sub-basins
Town of Lexington
Stream Management Plan
for the Charles River Watershed
FIGURE 2-2:
WATER QUALITY
WOODARD &CURRAN
SCALE: 1" = 0.5 miles
DOC: WaterQual.MXD
DATE: FEB. 2011
JOB NO.: 223267
DRAWN BY: JSM
SOURCE: MassGIS

2.2 EVALUATION OF HISTORICAL STREAM ALIGNMENTS

As part of the stream assessment, W&C coordinated with the Town to research, inventory, and map historical stream alignments and stream cross sections. The Town provided numerous historical maps and photographs, and W&C obtained additional historical maps and quadrangles from various sources (including MapMart.com for additional historical flyover images, Historicsurvey.com in Lexington, and historical.mytopo.com for historic topography). Using the best available information and best professional judgment, W&C georeferenced the photographs and historical maps in ArcMap, and overlaid the historical information on the Town's current orthophotographs, which illustrates changes in the streams over time. Maps and georeferenced images are included in Appendix A.

Streams within all sub-basins have been modified, rerouted, and/or straightened over the last 100 years as part of historical agricultural practices, or due to development of infrastructure or re-development of adjacent land areas. Straightening and dredging streams results in changes to the water table and impacts ecological functions.

In general, channelization and, subsequently, lower water tables, allow development to occur in many areas that otherwise would not support development. As agricultural management of floodplains (ditching and channelization) and stream channels (dredging and straightening) has diminished over the past fifty years in Lexington, water tables have naturally begun to rise. Additionally, increased impervious cover in the watersheds increases sediment loading and the deposition of inorganic material in stream channels, further restricting drainage. The combination of these factors can restrict drainage depending on the nature of the receiving stream. The study stream channels are largely low or very low gradient systems, and despite historic channelization which should increase stream velocities, many streams are now filling with sediment. The low slopes and extensive vegetation growth within or near stream edges result in insufficient velocities to produce periodic flushing flows that would seasonally remove organic material from the channelized stream segments.

Historical aerial photographs and maps show how Clematis Brook has been modified over time. Figure 2-3 is a historical map overlaid on current aerial photographs, and clearly shows that that Dunback Meadows was historically wetlands. Figure 2-4 shows the channelization of Clematis Brook since 1930. The figures in Appendix A show the evolution of Clematis Brook over the past 150 years.

Figure 2-3: Clematis Brook circa 1830

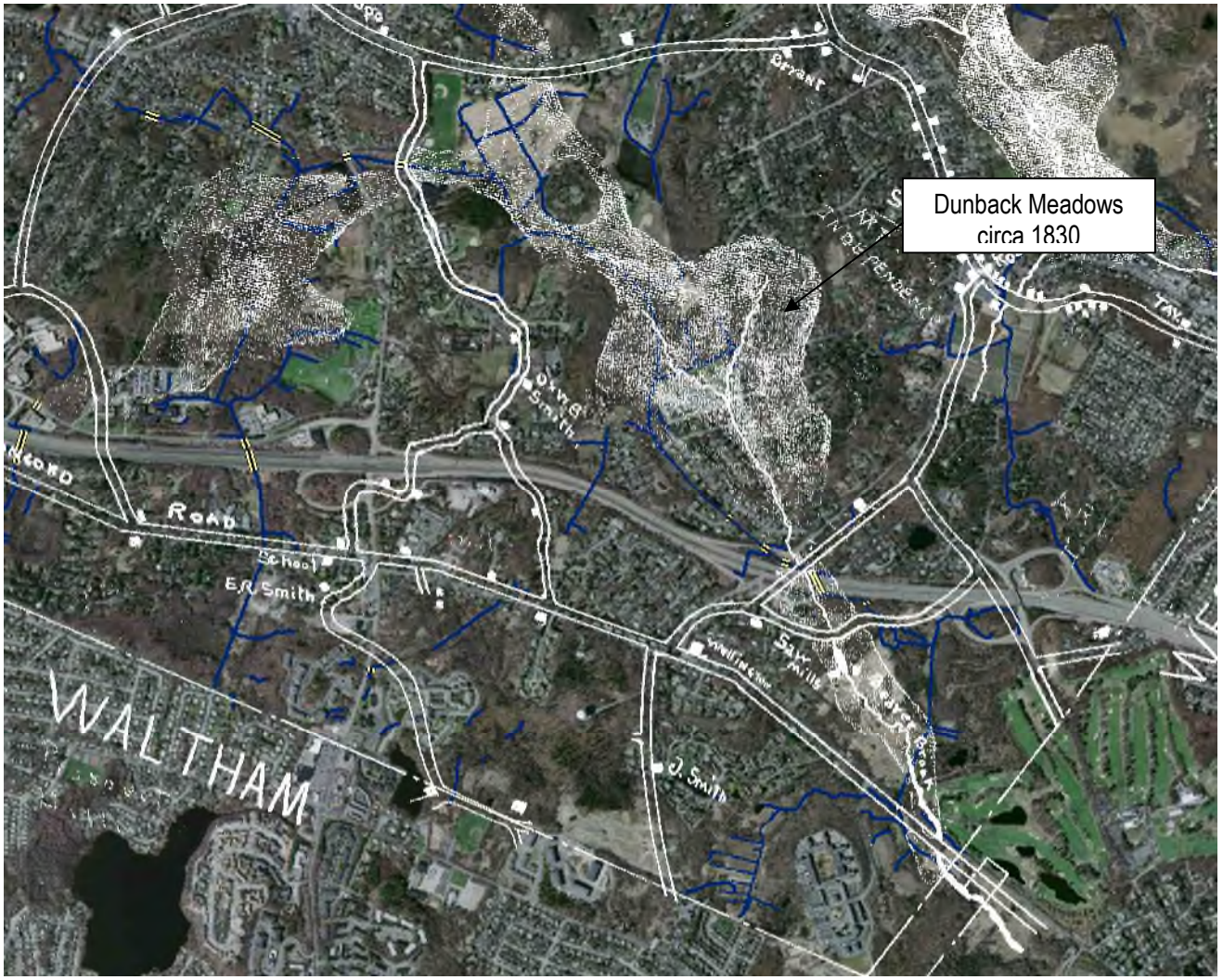


Figure 2-4: Clematis Brook, 1930 vs 2010

2.3 STREAM SURVEY

As part of the stream assessment, W&C and town staff performed a survey of the streams in the Charles River watershed within Lexington. The survey included a physical inventory of stream corridor conditions, with a focus on identification of impediments to drainage, obvious flood plain constrictions, and intact riparian areas that can safely provide flood mitigation and ecological value. Stream survey activities and findings are further described in Section 3.

2.4 ROADWAY AND DRAINAGE SYSTEM OPERATION & MAINTENANCE

Proper operation and maintenance (O&M) of roadways and their drainage systems are critical to maintaining safe roads and ensuring stormwater is effectively conveyed during precipitation events. O&M practices also can impact water quality and quantity; as snow melts, road sand and salt, as well as litter and other pollutants, are transported directly via sheet flow or through the drainage system to waterbodies. Road salt and other pollutants can contaminate water supplies and at high levels are toxic to aquatic life. Sand can create sand bars or fill in wetlands and ponds, impacting aquatic life, causing flooding, and hindering use of these resources. However, frequent sweeping of impervious surfaces will remove particulate matter and associated contaminants from impervious surfaces before they can be mobilized by the next rain event. Routine catch basin cleaning helps maintain adequate catch basin sump storage, thereby allowing catch basins to efficiently capturing coarse sediments and debris.

The Lexington Highway Division does not perform winter maintenance on State roads. MassDOT, formerly MassHighway, performs maintenance on State Highways (Route 2, Route 128 and all entrance and exit ramps) and on the following roads in Lexington, as shown in Figure 2-5.

- Pleasant Street from #108 to #141;
- Concord Avenue @ entrance of Route 2;
- Waltham Street from #753 to #890;
- Hayden Avenue from #16 to Waltham Street;
- Hayden Avenue from #95 to Spring Street;
- Spring Street from #128 to the end of the overpass of Route 2;
- Summer Street from #6 to the Arlington town line;
- Lowell Street from intersection of Maple Street to #114;
- Bedford Street from Bike Path to the Bedford town line;
- Marrett Road; and
- Maple Street.

W&C assessed the Town's and MassDOT's practices regarding 1) sand/salt application; 2) snow removal and storage; 3) street sweeping; and 4) drainage system maintenance. Practices related to these four types of maintenance activities were evaluated with respect to: requirements of the 2003 General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s); the draft NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems (MS4) located in North Coastal Massachusetts; MassDEP's Snow Disposal Guidance (Guideline No. BRPG01-01); and MassDEP Policy #BWP-94-092: Reuse & Disposal of Street Sweepings.

2.4.1 Sand and Salt Application

The Lexington Highway Division applies sand and de-icers to town roads using two methods: brine pre-treatment and standard rotating spreaders. In 2010-2011, the Town began using brine pre-treatment to reduce the amount of sand and salt used. The Town also uses rotating spreaders on the back of trucks to apply a sand and salt (sodium chloride) mixture to the roads. Both the effectiveness of the brine and the sand-salt ratio are temperature and weather dependent. The Highway Division uses best professional judgment for de-icing method and application rates depending on conditions observed. In fiscal year 2010, 66 tons of sand and 5,492 tons of salt were used.

As needed, the Town also applies sand and salt to parking lots and dedicated roads on public properties, including schools, town administration buildings, libraries, police and fire stations, the visitor center, and water and sewer properties. These public properties are listed in Appendix B.

According to the *MassDOT Snow and Ice Control Generic Environmental Impact Report* (Appendix B), for most multi-lane roadways and secondary roads, the deicing applications consist of salt (straight sodium chloride) or pre-mix of sodium chloride and calcium chloride at a 4 to 1 ratio. The general practice consists of salt application at a rate of 240 lbs per lane mile. MassDOT also uses liquid calcium chloride as either a pre-wetting agent or it is applied directly to the pavement. This direct pavement application of liquid calcium chloride can be performed both prior to the storm for anti-icing purposes or as a deicing method during the storm.

A mixture of sand and sodium chloride is sometimes used, particularly on roadway sections with steep grades, ramp sections and hazardous intersections. Very rarely is straight sand used because it has no effect on preventing ice bond formations and it has proven very costly to clean up and dispose of after the season, and it can accumulate within the roadway drainage system and be washed into receiving water bodies.

There are no designated "reduced salt" areas on town-maintained roads. Some portions of the state highways are designated and labeled as "reduced salt areas," as listed below and shown on Figure 2-5:

- Interchange at Route 2A, 1 mile westerly and 0.5 mile easterly;
- Interchange at Route 2, 1.8 miles westerly and 0.6 mile easterly; and
- Portion of 128 (I-95) from the Waltham town line to the interchange with Route 4 & 225.

MassDOT's standard practice in reduced salt areas is to maximize the use of pre-mix and liquid calcium chloride as alternative deicers, to reduce the quantity of granular sodium chloride. MassDOT closely monitors reduced salt zones during storms to ensure the proper timing of salt applications and minimizes the potential for overuse of deicing chemicals. Using pre-mix, which is a 4 to 1 blend of sodium chloride and calcium chloride, results in a 20% reduction in sodium chloride content compared to pure (straight) sodium chloride. Pre-mix is also mixed with sand to counter the "greasy" film that can be left on the road surface caused by calcium chloride. Thus, actual deicing applications in reduced salt areas generally consist of a mixture of sand and Pre-mix at a 1:1 ratio and applied at a rate of 240 lbs per lane mile. The Pre-mix/sand mixture results in a 60% reduction in the amount of sodium chloride applied in the reduced salt zone area compared to using straight sodium chloride.

All town sand and salt storage is located at the Public Services Building on Bedford Street. All stockpiles are in the building. The loading area is sloped so runoff flows into the building. There is a small, uncovered container near the entrance to the Public Services Building for residents to take free buckets of

sand in the winter. There are also two covered MassDOT facilities that store de-icing materials located in the Town of Lexington: one off Interstate 95 at Route 2A, and one off Route 2 near Watertown Street. These facilities allow for all salt loading operations to take place under cover to prevent spillage beyond the structure.

2.4.2 Snow Removal and Storage

The Lexington Highway Division plows streets and sidewalks throughout the winter season. Snow is piled on the sides of the roads. Occasionally, typically in late December or early January, it is necessary to remove snow in the downtown area. In these instances, snow is stored in an upland area on Westview Street, off Bedford Street, just beyond the Westview Cemetery (see Figure 2-5). This location is not within the Charles River watershed in Lexington.

2.4.3 Street Sweeping

The Highway Division sweeps all streets twice each year using mechanical broom sweepers. Sweeping is conducted continuously from spring through the fall until all streets have been swept twice. Sidewalks in the downtown area are swept once every year. School parking lots and roads are swept twice per year, typically in the spring and in late summer prior to the start of the school year. Street sweepings are temporarily stored at a town facility off of Hartwell Avenue for dewatering, within the Shawsheen River watershed (see Figure 2-5).

Sweepings are transported approximately annually to a regulated facility for disposal. The Town tracks dry weight of the material as it goes off site. At this time, the Town does not record the amount of material removed by location or on a regular time interval.

Most state roads are swept annually during the spring or early summer. Other state roads are swept by MassDOT on an as-needed basis. Sweeping of state roads is also conducted in conjunction with a structural project or to address a drainage backup problem. MassDOT District 4 utilizes mechanic broom sweepers. District 4 does not store any street sweepings at any facilities in Lexington.

2.4.4 Drainage System Maintenance

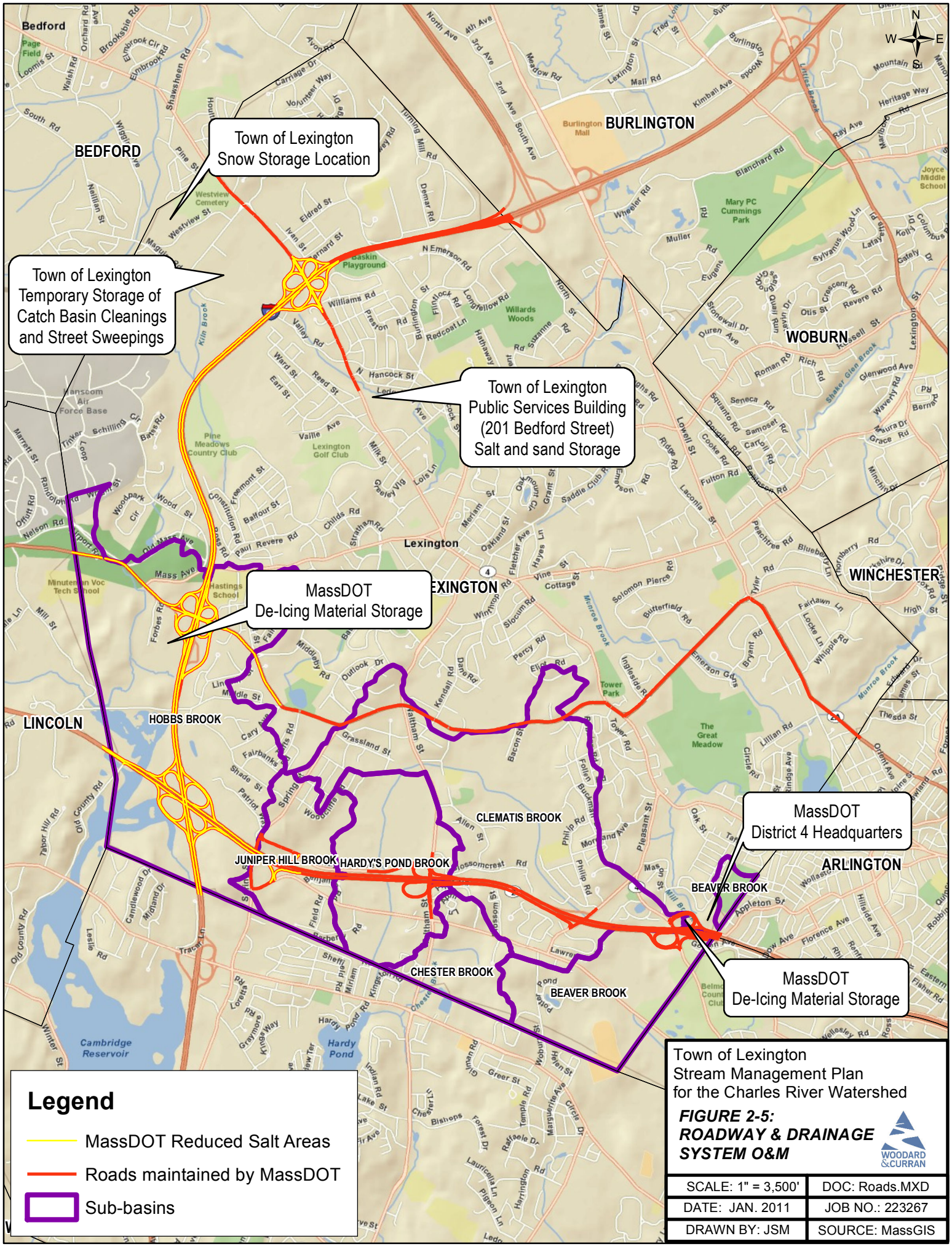
The Town has contracted with a vendor for catch basin cleaning and only conducts limited catch basin cleaning in-house. The contractor cleans each catch basin twice each year with a clam shell truck. No information about the catch basins is collected by the vendor during cleaning. Material removed from catch basins is temporarily stored and dewatered at the same facility as the street sweepings, at the Town facility off Hartwell Avenue, before being transported to a regulated facility for disposal. There is no program currently in place to measure or record the quantities of street sweepings or catch basin debris generated each year.

The Town's drainage maintenance program is currently "reactive." In response to previous flooding or other issues, the Town cleans some catch basins more often than twice per year. Due to recent flooding depositing sediment into the drainage system, town personnel cleaned some of the drain lines in the system. As a general practice, drain pipes are cleaned by jetting, as needed. The Town owns two vactor jet trucks for immediate response. The Town also has TV equipment to inspect the pipes, but camera work and sewer/drain line cleaning is typically done by a local contractor.

Town personnel and volunteer Watershed Stewards maintain some of the Lexington streams, such as Vine Brook, by removing fallen trees, branches, and other material. There is no other routine in-stream maintenance undertaken by town personnel.

MassDOT's drainage system maintenance program is also currently "reactive." MassDOT conducts catch basin cleaning and other drainage system work on an as-needed basis, typically in response to a problem or in conjunction with a structural project. MassDOT inspects most catch basins annually. MassDOT District 4 and its contractors utilize both clam shell and vactor trucks for catch basin cleaning. District 4 does not store any catch basin cleanings at any facilities in Lexington.

In addition, there are structural stormwater Best Management Practices (BMPs) (detention basins) along I-95 in the Hobbs Brook sub-basin. MassDOT inspects and maintains these as needed. There are also structural BMPs within the I-95 northbound rest area that are monitored and maintained by McDonald's Corporation.


Town of Lexington
Snow Storage Location
Town of Lexington
Temporary Storage of
Catch Basin Cleanings
and Street Sweepings
Town of Lexington
Public Services Building
(201 Bedford Street)
Salt and sand Storage
MassDOT
De-Icing Material Storage
MassDOT
District 4 Headquarters
MassDOT
De-Icing Material Storage
BEDFORD
BURLINGTON
WOBURN
WINCHESTER
ARLINGTON
LINCOLN
Lexington
HOBBS BROOK
CLEMATIS BROOK
JUNIPER HILL BROOK
HARDY'S POND BROOK
BEAVER BROOK
CHESTER BROOK
BEAVER BROOK
Cambridge Reservoir
Hardy Pond
Legend
MassDOT Reduced Salt Areas
Roads maintained by MassDOT
Sub-basins
Town of Lexington
Stream Management Plan
for the Charles River Watershed
FIGURE 2-5:
ROADWAY & DRAINAGE
SYSTEM O&M
WOODARD &CURRAN
SCALE: 1" = 3,500'
DOC: Roads.MXD
DATE: JAN. 2011
JOB NO.: 223267
DRAWN BY: JSM
SOURCE: MassGIS

3. STREAM SURVEY

This section summarizes stream survey actions and results. Photographs are included in Appendix C. The field assessment was conducted using digital forms and a summary of the field forms are included as Appendix D.

3.1 FIELD INVESTIGATION

W&C and the Town conducted a physical inventory of stream corridor and stream crossing infrastructure conditions, with a focus on identification of impediments to drainage, obvious flood plain constrictions, and intact riparian areas that can safely provide flood mitigation and ecological value. Specifically, the team conducted assessment of stream and floodplain morphology to document "natural" conditions that may influence flooding and conducted infrastructure assessment of streams to assess the impact of manmade structures on flooding and infrastructure condition.

In a meeting on May 14, 2010, W&C, the Town, and a member of the Watershed Stewards finalized the stream investigation areas, developed the survey protocol, identified known issues, and obtained other information such as access points, safety concerns, and equipment needs.

Table 3-1 summarizes the items assessed in the field.

Table 3-1: Items Assessed in Field Investigation

Category Assessed	Items Assessed
Structures	• Structure Type • Material • Length • Condition • Inlet and Outlet Condition, Span, and Clearance
Crossings	• Pavement and Crossing condition • Length • Abutment Height, including wildlife barrier • Adjacent Pollution Sources • Erosion Concerns
Stream Reaches	• Channel Stability, Bed Material, Bank Materials • Adjacent Fill/Channelization • Bank and Channel Width and Depth • Bank Erosion Conditions • Streamside Vegetation • Invasive Species
Stormwater Outfalls	• Size • Condition • Evidence of dry weather flow

Data were collected at 28 stream crossings located along the main channels of the six named streams within the Charles River watershed in Lexington.

W&C developed a database for the field collection and watershed mapping. The populated database is attached in Appendix D.

Table 3-2 provides a summary of the survey activities, including dates of site visits, accomplishments and other comments.

The crossings were initially identified based on Town of Lexington's GIS layers. Certain crossings, or portions of crossings, along the main channels were not assessed due to access restrictions. Several crossings were assessed that were not identified on existing maps. The following lists the number of stream crossings assessed by sub-basin:

- Juniper Hill Brook: 4
- Hobbs Brook: 6
- Hardy's Pond Brook: 3
- Chester Brook: 2
- Clematis/Beaver Brook: 13

Stream channels were assessed both above and below stream crossings and in areas associated with stormwater outfalls. Certain stream segments were not accessible due to soft substrate (muck), poison ivy and/or extensive vegetation. During the main stem stream inspections, any tributary identified as potentially adversely contributing to the main stem was noted. Hobbs Brook tributaries could be having negative impact on sediment loading on the main stem. Small intermittent and ephemeral channels in Upper Clematis Brook and urban drainage systems that discharge to the streams could be contributing nutrients and sand to Clematis Brook

Outfalls in the vicinity of the stream crossings were assessed for structural and maintenance condition and dry weather flow from mapped outfalls was noted on the field sheets included in Appendix D. Less than 0.5 cubic feet per second of dry weather flow was found at the outfall located off Pleasant Street in Clematis Brook (OF020275), but the flow appeared to be groundwater infiltration and did not have any signs of illicit discharge W&C found one outfall at the Bowman School that was not previously on the drainage map; these outfalls were mapped and are included in the geodatabase in Appendix F.

Table 3-2: Stream Survey Activities

Date	Personnel	Location	Purpose and Comments
May 14, 2010	Zach Henderson (W&C) Paul Hogan (W&C) John Livsey (Town) Michael Flamang (Town) Dave Pavlik (Town) Karen Mullins (Town) Emily Schadler (Town) Carolyn Levi (Watershed Stewards)	Samuel Hadley Public Services Building, Lexington, MA	Meeting to identify areas for survey, develop survey protocol, identify known issues and obtain information (access points, safety concerns, and conveyance needs).

Date	Personnel	Location	Purpose and Comments
May 27 – 28, 2010	Kyle Apigian (W&C) Zach Henderson (W&C) Dave Pavlik (Town)	Beaver, Clematis, Juniper Hill, and Hardy's Pond Brook	Assess stream channel, stream crossings and outfalls.
June 9 – 10, 2010	Kyle Apigian (W&C) Dave Pavlik (Town)	Chester and Hobbs Brook	Assess stream channel, stream crossings and outfalls.
June 30, 2010	Paul Hogan (W&C) Zach Henderson (W&C) Dave Pavlik (Town)	Clematis, Beaver, Chester, Hardy's Pond, and Hobbs Brooks.	Assess additional outfalls and select segments of stream channel. Visited Leitha Drive inlet on Hardy's Pond Brook in Waltham.
December 16, 2010	Zach Henderson (W&C) Dave Pavlik (Town)	Hobbs Brook – "Middle Street drainage area".	Assess stream crossings and urban drainage system for indications of impediments to drainage.
December 17, 2010	Lisa MacIntosh (W&C) Zach Henderson (W&C) Dave Pavlik (Town)	Conducted a stream walk along the Dunback Meadows reach of Clematis Brook and at several points immediately upstream and downstream of this reach. Additionally, the culvert at Concord Street and Beaver Brook was observed.	Evaluate restoration potential of the drainage system/stream and adjacent wetlands of Dunback Meadows as well as potential ecological impacts that may be associated with restoration, enhancement or maintenance activities.

3.2 OBSERVATIONS BY SUB-BASIN

The field survey confirmed that most of the streams in the watershed have been historically straightened and channelized. Channelization typically results in increased stream velocities, yet the assessed streams were mostly accumulating sediment. The apparent lack of recent channelization and dredging maintenance, natural low slopes and extensive vegetation growth within or near stream edges prohibit a sufficient stream velocity to produce periodic flushing flows, which would seasonally remove organic material from the channelized stream segments. All assessed stream channels, with the exception of the higher gradient Hobbs Brook tributaries, contain excessive organic deposition. This was apparent even after significant spring rainfall and flooding in 2010. Even minimal in-stream blockages within the straightened stream reaches appear to contribute to stagnant, backwater conditions and organic material accumulation. Without periodic removal of detritus, woody debris and sediments, the local water table will increase as wetlands return and engineered sections of stream will lose their hydraulic capacity. Almost half of stream crossing structures exhibited partially "submerged" inlets and outlets which is

likely due to lack of routine stream maintenance. Field identifiers referenced in the following sections are included on the CD in Appendix F and the Fact Sheets in Section 7.

3.2.1 Juniper Hill Brook

- Juniper Hill Brook appears to be in good condition with access to the floodplain and intact riparian areas despite apparent historic alterations (i.e. straightened stream channels). The sections north of Hayden Avenue (within the Hayden Woods) and also south of Concord Ave are largely forested with minimal floodplain encroachment.
- An engineered flow control structure above Hayden Avenue (ID #CR0604) presumably provides flow control for the downstream stormwater wet detention basin (on the property of 80 Haven Avenue) and likely creates an impoundment upstream during heavy rainfall. There is extensive sedimentation within the in-stream detention basin on the 80 Haven Avenue property which may compromise flow under Hayden Avenue but the culvert outlet was clear of debris but entirely submerged at the time of the survey. The "pond" height at the time of the survey was fully inundating the outlet of the outfall (OF052150). The pond height appears to be regulated by a small weir on the 80 Haven Avenue property.
- Moderate sedimentation and erosion occurs in the area between Hayden Ave and Concord Ave as a result of Route 2. No structural concerns were evident at the crossings.
- Lawn encroachment on the stream just below Concord Avenue (ID #CR0601) creates some minor channelization and bank erosion but is not a significant issue given extensive floodplain access in this reach.

3.2.2 Hobbs Brook

- Hobbs Brook appeared to be in good condition with reasonably high quality wetlands present in the vicinity of the Massachusetts Avenue/Marrett Road intersection but fragmented by streets and development.
- The drainage patterns at the north end of Hobbs Brook are complicated. The main channel is not well-defined and tributaries are heavily influenced by roadway drainage (including I-95), residential development and channelization.
- Two stormwater drainage areas discharge at one location west of the Hastings School (Outfall does not have an ID). There was an unusually high number of plastic bags containing dog waste in the outlet screen from the pipe network coming from School Street-Roosevelt Road area.
- Numerous field inlets in the drainage area above Middle Street are clogged with organic debris presumably contributing to minor flooding in drainage area. Misaligned and "patchwork" pipe/closed drainage networks likely contribute to additional hydraulic constraints and potential drainage problems. The open drainage system is in need of vegetation management and debris removal. Sanitary sewer pipe cover in at least one location is contributing to drainage problem. There appear to be some "natural" areas within this drainage area that may be retrofit for nutrient control and peak flow reduction. The following IDs can be referenced on the Fact Sheet 6 in Section 7.
    - CR0507- 24" RCP crossing of Lincoln Street has slight structural deficiencies, including joint separation and pavement slumping. 24" culvert may be undersized at this location. 8"CMP outfall at this crossing hanging and may be structural issue in future. Crossing could be repaired if Town does full depth roadway reconstruction.

- 0506 - Outlet structurally okay but skewed pipe alignment just upstream of this outlet may be contributing to hydraulic issues upstream. Complicated drainage system above this outlet needs further evaluation through televising or other method.
- 0508 - Fully clogged field inlet of unknown size or material with grate.
- 0514 - Old 12" x 16" fieldstone culvert for old roadway crossing intermittent stream channel. Presumed flow restriction at this structure.
- 0509- Sanitary sewer pipe cover creating impoundment. Existing 6" asbestos concrete drain pipe presumed to provide drainage through fill is clogged and inlet is buried. Need to determine more efficient at-grade crossing potentially with insulation cover.
- 0510 – 24" RCP culvert inlet is 75% clogged with organic debris. The inlet to the incoming flow path is skewed and there are moderate structural issues with 3' fieldstone headwall.
- 0511- Fully submerged 24" outlet due to vegetation and organic debris impoundment in downstream ditch.
- 0512 - Culvert inlet is partially clogged (25%) with organic debris. Headwall has minor structural deficiencies and skewed alignment.
- 051- Outfall is 75% blocked with sediment and debris. 5' vertical endwall has moderate structural issues.

3.2.3 Hardy's Pond Brook

- There is minor sediment accumulation between Hayden Drive (ID# CR0403) and Route 2 (ID# CR0402) along Hardy's Pond Brook. It is likely that the sediment accumulation is a function of winter sand migration through the open drainage swales from Route 2. Both swales discharge at this location and possible hydraulic restrictions in the area between the crossings may contribute to this deposition. It does not appear that hydraulics through the crossings would be significantly compromised as a function of this sediment accumulation, but winter sand migration downstream into lower Hardy's Pond Brook may exacerbate drainage issues in lower Hardy's Brook.
- An important area of focus in this watershed is the crossing at Concord Avenue (ID# CR0401). The twin 36" pipes were fully submerged at the time of the survey and appear to be in fair to poor structural condition. A significant accumulation of organic debris and trash has accumulated above the Concord Avenue crossing due to the submerged condition of this crossing. Based on observation of the culverts via metal probe, the culvert outlets appeared to be relatively clear of sediment accumulation indicating that velocities through the Concord Avenue crossing may clear the structures despite being entirely submerged.
- The Hardy's Pond Brook stream flows into a 46" RCP culvert inlet near Leitha Dive in the City of Waltham. While hydrologic modeling was not conducted, it is W&C's professional judgment that this pipe is undersized to handle conveyance from the Hardy's Pond Brook watershed. Additionally, the outlet for this culvert was close to 75% clogged at the time of W&C's site investigation. Give the very slight changes in surface elevations from the Route 2 to the inlet at Leitha Avenue (less than 2 feet), a drainage constriction at Leitha Avenue has the potential to influence hydraulic capacity at Concord Avenue during peak flow events. Drainage/minor flooding issues in this portion of the Hardy's Pond Brook watershed are well documented by streamside landowners. It is not likely that drainage restoration via sediment or material removal

will have long-term success within Lower Hardy's Pond Brook without addressing the flow restriction in the City of Waltham.

3.2.4 Chester Brook

- Chester Brook appears to be a small, high quality stream prior to entering closed drainage near the City of Waltham. Stormwater discharges at Concord Avenue are likely to periodically impact this stream but overall the stream channel is unimpacted by floodplain constrictions above Waltham St.
- The stream enters a large detention pond at the Brookhaven property at Waltham St. before passing beneath Waltham Ave (ID# CR0201). It is not clear whether this stream/drainage enters Hardy's Pond directly or via Hardy's Pond Brook.
- The existing conservation ownership and/or easements in wetland areas in Chester Brook would allow passive or engineered stream channel/wetland restoration to occur in targeted areas with little, if any, impact on private or public infrastructure. The historic straightening of stream channels in Lexington and minimal stream "power" due to low stream gradients may warrant active drainage restoration activities as opposed to only passive stream/floodplain restoration (i.e. "let nature do it").

3.2.5 Clematis/Beaver Brook

These "streams" have been aggregated as the Clematis Brook is the headwater reach of Beaver Brook and are discussed as one sub-basin below. Comments begin at the headwaters and work downstream.

- The headwaters of Clematis Brook are largely developed in low to mid-density residential land uses. The stream flows through small wetlands isolated by streets and culverts in the area around Grassland Street and Winston Road before entering a hand-placed rock lined inlet above Valleyfield Street (ID# CR0312). It is possible that flow is constrained at this inlet during peak runoff events. This was corroborated by adjacent residential landowners during W&C's site visit. It also appears (according to the Town's drainage system maps) that the Clematis Brook at Valleyfield Street accepts runoff from a large drainage area, including the intersection Marrett Drive and Waltham Street. This may compromise hydraulic capacity within the culvert under Valleyfield Street and further exacerbate flow constrictions at the above-mentioned inlet.
- A trail crossing just southeast of Valleyfield Street (ID# CR0314) has minor erosion issues at the headwall and the culvert providing this crossing has minor structural issues.
- The culvert at Waltham St. (ID# CR0311) is partially submerged and the outlet is largely plugged by inorganic sediments. The outlet of this culvert was less than 25% open at the time of the survey. Hydraulic constraints at this crossing (due to culvert size or sedimentation) is likely influencing the drainage (or lack thereof) around the Waltham Street Farms.
- No apparent sedimentation issues at the Brookside Avenue crossing (ID# CR0310) but even minor hydraulic restrictions at this location may influence upstream drainage potential. The stream is extremely low gradient between Valleyfield Street and Brookside Avenue (less than 0.006 % slope)
- Three Clematis Brook trail crossings are present in Dunback Meadows that have minor to moderate structural issues and headwall erosion. One of the three culverts (ID# CR0309) may be undersized for the location.

- Dunback Meadows consists of a variety of habitats, including wet meadows, emergent wetlands and forested wetlands and uplands, through which run several man-made drainage channels and recreational trails.
- Historically an agricultural area, portions of Dunback Meadows have been altered through routine mowing, filling and/or draining. Much of Clematis Brook has been straightened and realigned, resulting in channelization, with often limited hydraulic connection between it and the adjacent wetlands and floodplain. Alterations to soil, vegetation cover and hydrology have resulted in the presence of many invasive plant species throughout Dunback Meadows, including glossy buckthorn (*Frangula alnus*), purple loosestrife (*Lythrum salicaria*), multiflora rose (*Rosa multiflora*) and common reed (*Phragmites australis*).The stretch of brook that flows by the Clarke Middle School has a limited vegetative buffer and consequently may endure enhanced rates and volume of stormwater runoff from the adjacent parking lot and ballfields.
- The area immediately south of the Clarke Middle School ball fields consists of open wet meadow habitat, which is relatively rare for the region. This meadow has been drained and cultivated until recently. A consequence of such alterations has resulted in a lowering of the water table and widespread presence of invasive, non-native plant species, such as purple loosestrife and *Phragmites*.
- Four crossings exist in the vicinity of the Route 2 interchange on Pleasant Street. This section of stream channel has been engineered from Bowman Elementary School to Pleasant Street. This section of stream, particularly above the Pleasant Street interchange, is exhibiting signs of significant organic material accumulation with probable impacts on its design capacity. There are no structural issues with culverts in this area but some outfalls are submerged from above Bowman School to Pleasant Street due to organic deposition and increasing water tables.
- There are significant structural issues with the culverts under Concord Avenue and Beaver/Clematis Brook (ID# CR0101).
- The existing conservation ownership and easements in wetland areas in Dunback Meadows may allow passive or engineered stream channel/wetland restoration in targeted areas with little, if any, impact on private or public infrastructure. However, the historical changes to the area deliberately lowered the water table, and restoration will contribute to raising the water table to its natural level. The minimal hydraulic slopes and lowered water table in the watershed significantly influence design and modeling of any drainage restoration activity, as only minor impediments to flow may more quickly and dramatically impact the hydraulics of upstream drainage infrastructure, especially once the water table is raised from restoration activities. The historic straightening of stream channels in this area and minimal stream "power" could warrant the need for active drainage restoration activities as opposed to only passive stream/floodplain restoration (i.e. "let nature do it").

4. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This section presents conclusions and recommendations to summarize and address adverse conditions identified through the stream assessment. Recommendations are divided up into projects and action items. Section 7 includes fact sheets that summarize the recommendations.

Recommendations are grouped into five categories:

- in-stream recommendations (infrastructure restoration, drainage restoration, and wetlands protection);
- drainage investigation recommendations;
- roadway and drainage system O&M recommendations;
- recommendations for drainage restoration practices; and
- recommendations for coordination with EPA's Phase II Small MS4 General Permit.

Section 5 summarizes the permits required for these recommendations, as well as the proposed permitting process. Potential funding opportunities for projects, action items, and long-term stream maintenance are identified in Section 6.

4.1 GENERAL FINDINGS AND CONCLUSIONS

Based upon the results of the field work conducted by W&C and the Town of Lexington and from the compilation of data, we conclude that:

1. Culverts were commonly obstructed, including culverts that conveyed outfall flow.
2. Drainage outfalls were generally clear of obstructions, except those that were in stream channels impacted by organic debris and sedimentation.
3. Sediment at culverts appears to be predominately from settlement of organic and inorganic material caused by downstream obstructions and low gradient stream flow.
4. In addition, over time, sand from winter maintenance activities has contributed to clogged culverts and outfalls.
5. For sediment issues, the Town should prioritize projects that clear stream obstructions and sediment in culverts, outfalls and stream channels, as opposed to upstream drainage infrastructure (pipe and catch basin) cleaning.
6. Infrastructure structural conditions varied considerably. However, the culvert at Beaver Brook and Concord Avenue is failing and causing road failure, undersized culverts at Waltham Avenue and Valleyfield Street are contributing to local flooding, and the culverts on Hardy's Pond Brook at Concord Ave show signs of distress.
7. Hydraulic limitations in Waltham are affecting Hardy's Pond Brook in Lexington.

8. To achieve a routine maintenance program for the drain outfalls and stream system, the Town must first undertake projects requiring capital funding and comprehensive permitting. A routine maintenance program can begin once the sediment problems stabilize.
9. Several opportunities exist for stream and wetlands protection and restoration.
10. Specific findings are discussed for each priority project/program in the Fact Sheets in Section 7.

4.2 PRIORITIZED LIST OF PROJECTS AND ACTION ITEMS

Based upon the results of the field work conducted by W&C and the Town of Lexington and from the group discussion on project priorities held on October 20, 2010, the following are the three highest-priority areas recommended for more detailed evaluation leading to remediation and restoration work:

- Clematis Brook in the vicinity of Valleyfield Street to the Dunback Meadow area;
- Tributaries to Hobbs Brook (eastern side) that have historical drainage problems; and
- Beaver Brook/Clematis Brook Concord Avenue culvert crossing.

These three areas were deemed high priority because they are subject to localized flooding and the infrastructure is in need of substantial structural repair.

Fact Sheet 2 in Section 7 includes a more detailed summary and prioritization of the projects. This Section also includes a figure showing the location and priority of the projects and action items. Projects are color-coded based on priority (red is high priority, orange is medium priority, and yellow is low priority).

4.3 IN-STREAM RECOMMENDATIONS

The areas that need drainage restoration, infrastructure repairs, drainage restoration or wetlands protection are listed below.

4.3.1 Infrastructure Restoration

Three areas have been identified where W&C recommends that restoration of drainage infrastructure should be made. Each of the following three areas and the proposed restoration are further discussed in Section 7.

- Concord Avenue at Beaver Brook
- Valleyfield Street at Clematis Brook
- Concord Avenue at Hardy Pond Brook

4.3.2 Drainage Restoration

Three areas have been identified where W&C recommends that restoration of the stream, through removal of in-stream organic and inorganic material, should be made. Each of the following three areas and the proposed restoration projects are further discussed in Section 7.

- Valleyfield Street to Brookside Avenue at Clematis Brook

- Concord Avenue at Hardy Pond Brook
- Clematis Brook from Bowman School to Pleasant Street

4.3.3 Wetland Protection

Three areas have been identified where W&C recommends that flood mitigation through wetlands protection could be made. Each of the following three areas and the proposed projects are further discussed in Section 7.

- Dunback Meadows at Clematis Brook
- Beaver Brook between Concord Ave and Route 2
- Chester Brook off Waltham Street

4.4 DRAINAGE INVESTIGATION RECOMMENDATIONS

Two areas have been identified where W&C recommends additional investigation of the drainage infrastructure. Each of the following areas and proposed investigation items are further discussed in Section 7.

- Middle Street at Hobbs Brook Tributaries
- Brookhaven Property at Waltham Street on Chester Brook

4.5 ROADWAY AND DRAINAGE SYSTEM OPERATION & MAINTENANCE RECOMMENDATIONS

Recommendations related to snow removal, winter sanding and salting, street sweeping, and drainage system maintenance (such as catch basin and outfall cleaning) are described on the Fact Sheet 15 titled "Roadway and Drainage System Operation and Maintenance" in Section 7.

4.6 RECOMMENDATIONS FOR DRAINAGE RESTORATION

As part of this project, W&C developed specifications for methods of stream cleaning with respect to the following regulatory performance standards and guidelines:

- Army Corps of Engineers Programmatic General Permit;
- Massachusetts Best Management Practices and Guidance for Freshwater Mosquito Control;
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas;
- U.S. Department of Transportation Stream Stability at Highway Structures;
- Army Corps of Engineers Channel Rehabilitation: Processes, Design, and Implementation;
- Massachusetts Stream Crossing Handbook; and
- Massachusetts River and Stream Crossing Standards.

Fact Sheet 13 in Section 7 provides a brief overview of stream cleaning and maintenance activities, based on these standards and guidelines. The permit path associated with stream cleaning is further described in

Section 6. For reference, Appendix G includes a CD containing electronic versions of the above-listed documents.

4.7 COORDINATION WITH EPA'S PHASE II SMALL GENERAL PERMIT REQUIREMENTS

In 2003, EPA released the General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s). This General Permit regulated municipal stormwater discharges and identified six Minimum Control Measures (MCMs) to reduce the discharge of pollutants from the storm drain system. This permit expired on May 1, 2008, but has been administratively continued until the next general permit is in effect.

As previously mentioned, the EPA released a draft NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems (MS4) located in north coastal Massachusetts ("EPA Phase II Small MS4 General Permit"). This draft General Permit specifically regulates communities located within the Charles River watershed and identifies Best Management Practices the Town must implement to control stormwater pollution. Among other requirements, the Town must address the Final Phosphorus Total Maximum Daily Load for the Lower Charles River watershed by developing a Phosphorous Control Plan (PCP) to reduce phosphorus in stormwater by 57.8% from the Town's portion of the watershed, through both structural and non-structural controls. One structural control is reduction or disconnection of impervious area, where appropriate, to reduce stormwater pollution and help promote watershed health. The draft permit also requires the Town to track annual increases or decreases in impervious areas tributary to the storm drain system.

W&C reviewed the existing 2003 MS4 General Permit, as well as the draft General Permit, for opportunities to merge and coordinate activities. The Fact Sheet titled "MS4 Permit Compliance" in Section 7 summarized how recommendations from this report can be coordinated with requirements of the existing and pending MS4 General Permits.

5. PERMITTING REQUIREMENTS AND RECOMMENDATIONS

The prioritized projects and the long-term drainage restoration work require numerous local, state, and federal permits. This section list the potential permits required.

5.1.1 Permits Assessed

W&C assessed the following permits to determine which will likely be required for the recommended work summarized in Section 4 and further detailed in Section 7:

- Local conservation commission wetlands order of conditions;
- Certificate of the Secretary of Energy and Environmental Affairs on the Environmental Notification Form under Massachusetts Environmental Policy Act (MEPA);
- EPA Construction General Permit;
- EPA Dewatering General Permit;
- MassDOT Highway Access Permit;
- MassDEP 401 water quality certification;
- US Army Corps of Engineers Department of the Army General Permit Commonwealth of Massachusetts;
- Massachusetts Historical Commission Project Notification Form (PNF);
- Massachusetts Endangered Species Act (MESA) Project Review;
- Chapter 91 waterways license; and
- Local permits (Permit to Open or Occupy Street/Sidewalk, Trench Permit, Tree Removal Permit, etc).

The Fact Sheets 17 and 18 in Section 7 lists these permits, the required forms, permit agency, trigger, projects requiring the permit, permit timelines, application fees, reference information, and assumptions. Permits associated with each project, as well as permits potentially triggered by drainage restoration work, are specified on the each Fact Sheet in Section 7. In addition, the recommended permitting approach is presented in Fact Sheet 17.

6. POTENTIAL FUNDING OPPORTUNITIES

This section presents a prioritized summary of grant and loan opportunities, including non-traditional grant sources, based on specific projects, funding program requirements, funding range, schedule for applications, estimate of application effort, targeted recipients, and other relevant information. Specific funding opportunities for projects and action items are included on the Fact Sheets in Section 7. Engineer's opinion of probable budgetary cost for structural projects ranked as high and medium priority are included in Appendix E.

6.1 FUNDING OPPORTUNITIES ASSESSED AND IDENTIFIED

W&C assessed over 50 federal and state grant and loan opportunities to identify potential funding for the recommended work summarized in Section.4 and further detailed in Section 7. Based on this assessment, W&C identified the following environmentally-focused funding and service opportunities, which are applicable to one or more projects or action items:

- Coordination with the East Middlesex Mosquito Control Project;
- Massachusetts Natural Resources Conservation Service (NRCS) Watershed Protection and Flood Prevention Program Grant;
- MA NRCS Wetlands Reserve Program Grant;
- EPA Wetlands Program Development Grant;
- EPA/US Fish and Wildlife Association Five- Star Restoration Program Grant;
- MassDEP Clean Water State Revolving Fund Loan;
- Massachusetts Department of Conservation and Recreation Rivers and Harbors Grant;
- Massachusetts Division of Ecological Restoration River Restoration and Revitalization Priority Project Grant;
- Executive Office of Energy and Environmental Affairs Office of Coastal Zone Management Wetland Restoration Grants for Priority Projects; and
- Massachusetts Division of Fish and Game Riverway's Stream Team Implementation Awards Grant.

The Fact Sheets 19 and 20 in Section 7 lists these grants and loans, contracting entity, eligible applicants, eligible projects, due date, links, and project for potential funding match. Additionally, traditional municipal programs could provide funds for specific projects that address other important municipal priorities. These include:

- Chapter 90 local transportation aid funding for road and drainage projects.
- Community Preservation Act (CPA) funds for open space (Dunback Meadows).

Potential funding opportunities associated with each project are specified on each Fact Sheet in Section 7. A recommended funding approach is also discussed on Fact Sheet 19 in Section 7.

6.2 ADDITIONAL FUNDING PROGRAMS

Other funding programs are available that can supplement the conventional programs. These programs have drawbacks that make them less attractive. Drawbacks may include the cost and effort to complete the application process, intense competition, agency's geographic preferences, low award value, burdensome reporting requirements, and restrictive project focus. However, some municipalities have had success by directly soliciting from the funding agencies and combining funds into a more comprehensive and cohesive funding program.

- NOAA Restoration Center;
- Gulf of Maine Council (in conjunction with NOAA Habitat Restoration Grants Program);
- American Rivers;
- EPA Targeted Watershed Grants;
- Section 319 Nonpoint Source Pollution Competitive Grants Program; and
- Section 604b Grant Program - Water Quality Management Planning.